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ABSTRACT

A study was undertaken to investigate the effects of directed response training to focus attention and to assess the impact of pictorial integrated stimuli on incidental learning. A total of 140 second- and fifth-grade children were administered a two-choice discrimination learning task consisting of three parts: original learning, overtraining, and a nonreversal shift task. The original learning task was the same for all participants. During overtraining trials, children either made a response that the experimenter said to make (response training) or responded without help. A second task was administered in which, for some children, "real-life" pictorial integrated stimuli replaced geometric forms. Other children saw the same stimuli as in original learning. Results indicated that response-trained second graders learned the shift task more rapidly than did untrained second graders. The poorest shift task performance was made by response-trained fifth graders. In addition, learning was more rapid when pictorial stimuli were used on the shift task. These findings supported the conclusion that younger children selectively attend when an attentional strategy is available and generalize that attention to pictorial integrated or more realistic stimuli. Poor learning by response-trained fifth graders raised questions as to the appropriateness of the response training strategy for older children's learning. (Author/RH)

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Attention Strategies and Children's Incidental Learning

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Note: This study is based on a Master's Thesis conducted by the first author under the direction of the second Author and submitted to Purdue University in partial fulfillment of the requirements for the Master of Science Degree. We thank Mr. Richard Gibson, Mr. Harry Moore, and Mr. Jerry Martin, Principals in the Frankfort, Indiana, Community School Corporation for permitting their children to participate in this research. We also thank the thesis Committee members, Peter Urculioli and Gerald E. Gruen, for their assistance in this work. Requests for reprints should be addressed to Francine Blumberg, Department of Psychological Sciences, Purdue University, West Lafayette, IN 47907.

Running Head: STRATEGIES AND INCIDENTAL LEARNING

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Abstract

The effects of directed response training to focus attention and pictorial integrated stimuli on incidental learning were investigated with 140 second- and fifth-grade children. During overtraining (OT) trials, children either made a response that the experimenter said to make (Response Training) or responded without help. A second task was administered in which, for some children, the cues were imbedded in a more realistic setting. The other children saw the same stimuli as in original learning. The results indicated that the Response Trained second graders learned the shift task more rapidly than did the untrained second graders. The poorest shift task performance was by the Response Trained fifth graders. In addition, learning was more rapid when pictorial stimuli were used on the shift task. These findings supported the conclusion that younger children selectively attend when an attentional strategy is available and generalize that attention to pictorial integrated or more realistic stimuli. The poor learning by the response trained fifth graders raised questions as to the appropriateness of the response training strategy for older children's learning.

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A consistent finding in the developmental literature is that young children do not appear to attend to the relevant cues on learning tasks (e.g., Crane & Ross, 1967; Hale & Piper, 1974). As a result, children younger than eight years learn more about irrelevant than relevant task cues, while the opposite is true of children older than ten years (Crane & Ross, 1967; Hale, 1979). Often these developmental differences in what has been termed selective attention have been attributed to cognitive mechanisms that are presumed to underlie children's learning. In general, these explanations have been less than successful.

Specifically, younger children are presumed to be less efficient learners because of a deficiency in the ability to direct attention or to attend selectively (Stevenson, 1983). Among the possible effects of that deficiency are that the younger children may be unable to ignore irrelevant stimuli during learning (Siegel & Stevenson, 1966), may have a smaller attentional range than older children (Hale & Taweel, 1974b), or may be less flexible in redirecting their attention than are older children (Hale & Taweel, 1974a). However, recent findings have led to a change in these views. Thus, Hale, Green, Taweel, & Flaughers, (1978) have reported that children as young as five years of age apparently are able to deploy or redirect attention

efficiently. Thus, the research focus has shifted to specifying when young children can efficiently deploy attention (Birch, 1978; Lane, 1979).

Two variables that have been strongly linked to children's ability to attend selectively are stimulus integration and attention to redundant information. The first of these, stimulus integration, has been defined as aspects of a stimulus complex which appear in the same visual field and are perceived as a unified whole (Hale & Piper, 1973).[1] Hale and Piper (1973, 1974) examined the effects of novel forms of integration using pictorial stimuli in varying levels of interactivity or integration (e.g., a horse holding a guitar -- weak integration -- or a horse playing a guitar -- strong integration). This kind of pictorial integration was expected to facilitate incidental learning at each age, but the opposite pattern was observed. Hale and Piper attributed these results to a presumption that the pictorial integrated stimuli were more discriminable than the integrated colors and shapes used in other studies (see Footnote 1).

Attention to stimulus cues and cue redundancy, the second variable, refers to situations where additional cues are paired with the relevant cue in a learning task. One such task is the component selection task devised by Hale (Hale, 1979; Hale & Morgan, 1973; Hale & Taweel, 1974) in which children learn the spatial position of stimuli that have two relevant and redundant components (e.g., a color and a shape). After criterion, the children's retention of each component is evaluated. Hale's findings have generally indicated that younger children attend to cue redundancy less than do older children (cf., Hale, 1979, for a

review).

Another task used to study attention to redundant cues, the Irrelevant-Relevant Redundant (IRR) cue task, was devised by Crane and Ross (1967). This task is a variation of the discrimination shift paradigm (with one relevant and one irrelevant dimension). The first discrimination task includes overtraining trials in which formerly irrelevant cues become redundant and relevant (and are correlated with the original relevant dimension). In the second task, a nonreversal shift, the redundant dimension becomes relevant and the original relevant dimension becomes irrelevant. When the correct nonreversal cue had been paired with the negative cue during overtraining, second graders made more shift task errors than did fourth or sixth graders (Crane & Ross, 1967; Kemler, Shepp, & Foote, 1976). These results were interpreted as indicating that younger second-grade children attended to the redundant or incidental stimulus cues more than did older children. Crane and Ross concluded that younger children's greater initial attention to all cues interfered with later shift performance. Accordingly, attention to the newly redundant cue during overtraining was assumed to reflect more incidental learning rather than more efficient deployment of attention.

Crane and Ross' interpretation was inconsistent with other effects of selective and nonselective attention. One would expect that children who have attended more to one dimension than another would learn a task based on that dimension more rapidly or more efficiently (i.e., with fewer errors). Yet Crane and Ross made the opposite conclusion, perhaps because they misinterpreted the

effects of attention during the original learning task. Rather than continuing to attend to both irrelevant and relevant dimensions, the younger children's attention may have become focussed and limited to the cues of the relevant dimension during overtraining. The older children, however, were able to redirect their attention by the end of the criterion run, thus learning more about both dimensions. As a result, the younger children would be less likely to alter or redirect their attention to the newly relevant cues in the shift task, thereby increasing the difficulty of that task. The older children, having already attended and learned about the cues of both dimensions, should acquire a nonreversal shift more easily (relative to the younger children). Our position is that by the end of the original learning task, the younger children's attention appeared to be selective because it was limited to the relevant cues. This interpretation, considered with Hale's results, implies that the conditions in which young children will direct attention to the relevant cues must be specified. Second, since children's ability to direct attention (even to the "wrong" cues) extends beyond simple learning tasks, experiments should be designed to show that such "control" goes beyond the immediate stimulus situation.

This study investigated one of the settings in which children's attention might be directed to the relevant task cues. A variation of the IRR task was used in which a response training procedure used by Novak & Offenbach (in press) was introduced for the overtraining trials. Novak and Offenbach told each child which stimulus to choose, but not why to choose it. Children who were so instructed learned both reversal and non-reversal shift

tasks in a manner comparable to those children who attained criterion by making their own responses. Thus, Novak and Offenbach's procedure enabled children who might not otherwise have done so to direct their attention to the relevant cues from the onset of the task. The possibility that the directed responses could direct, or redirect, attention was tested here using the IRR task where the procedure could be initiated after criterion had been attained. Another goal in this study was to determine whether redirected attention would generalize to different stimuli. Therefore, two different sets of stimuli were used for the nonreversal shift. One set of stimuli was identical to those used in the original learning task. The second set was a variation of Hale et al.'s (1974) pictorial integrated stimuli. The items used here consisted of integrated compounds of life-like household items that are commonly found together (e.g., a sofa and a chair) and were more realistic than the horse and guitar combinations used by Hale and Piper (1974).

Method

Subjects

One hundred forty children, 92 second graders (44 males and 48 females) ranging in age from 7 years, 1 month (mean = 8,3 years) and 48 fifth graders (26 males and 22 females) ranging in age from 10,4 to 12,7 (mean = 11.0 years) participated in this study. All the children attended elementary schools within a small midwestern community.

Design and Procedure

The children were tested individually in a quiet room provided by the school. Each participant was assigned randomly to one of four experimental conditions of a three factor design (Grade: 2 and 5; Training Condition: Response Training or No Training; and Stimulus Type: Pictorial or Geometric). The children were administered a two-choice discrimination learning task consisting of three parts: original learning, overtraining, and a nonreversal shift task.

The learning task stimuli varied on three binary valued attributes: size (large -- 7.5 cm X 2.5 cm and small -- 5.2 cm X 2.8 cm); form (rectangles and ovals); and colors (yellow or blue). They were photographed using 35 mm color transparencies. Each slide depicted a pair of geometric or pictorial stimuli. The pictorial integrated stimuli consisted of living-room scenes including a large or small patterned couch (rectangular or oval) accompanied by an appropriately sized lamp and floor rug. Each couch was the same size as its geometric counterpart. The colors of these stimuli were the same as those used for the geometric stimuli. In addition, a pattern of vertical stripes overlaid the colors. The stimuli were projected onto a Flashed Opal Glass Screen (27.7 by 27.7 cm) using a Kodak Carousel Random Access (RA-950) Projector.

The original learning task was the same for all participants. The task was introduced as a "guessing game" in which one of two pictures was described as the "right one to choose" and the other was the "wrong one to choose." The children also were instructed to "try hard to find the correct picture every time." The

children were told they could point to the "correct" picture, Following each response (here and during overtraining and the shift task), the experimenter told the child whether the response was correct or incorrect. A color cue, blue or yellow, was correct for original learning. The two other attributes, size and shape, were irrelevant. The task was presented for 64 trials or until a criterion of 10 consecutive correct responses was attained. The spatial position of the each cue was randomized over blocks of four trials so that one cue of each dimension was on the same side three times in four trials (this pattern prevented position response habit from corresponding to a criterion run).

The 16 overtraining trials were administered immediately following the last criterion trial. The experimenter made the following statement to the children in the Response Training condition: "Now, for a while, I am going to tell you which picture to point to. Please point to the picture I tell you to point to." The children in the No-training group were told that they would see some more pictures and should continue trying to find the correct picture every time. These instructions were administered in order to make the task as similar as possible to the response training condition. On the overtraining trials, the formerly irrelevant size cues were made redundant with color (e.g., large blue rectangle and large blue oval might be correct). The shape cues remained irrelevant.

Part three of the experiment consisted of a nonreversal shift task in which the size cue paired with the correct color cue

during the overtraining trials was made relevant and the formerly relevant color cues became irrelevant. The shape cues again remained irrelevant. In addition, for half of the children, the "real-life" pictorial integrated stimuli (described above) replaced the geometric forms. As in original learning, the task was presented for 64 trials or until a criterion of ten consecutive correct responses was attained. Following the shift task, the experimenter thanked the child and took him or her back to the classroom.

Results

The primary analyses were computed on the number of errors made during original learning and on the shift task for those children who learned the first task. Preliminary analyses indicated that while many of the younger children failed to attain criterion in the original learning task, there were no obvious differences between the groups (the mean age for both learners and nonlearners was 8,1; $t[88] = .02$). Although half of the nonlearners responded perseveratively to one cue (from an irrelevant dimension), no one cue was "more popular" than any other ($X^2 = 0.39$; $p > .05$).

The first analysis of variance of the learning task data was computed on the errors made in the original learning task. As expected, only the main effect of grade was significant, $F(1,83) = 7.82$; $p < .05$, and the fifth graders made fewer errors ($mean_5 = 6.22$; $mean_2 = 10.54$).

A Stimuli by Training by Trials (blocks of eight trials) repeated measures analysis of variance was computed on the shift

task errors to evaluate the experimental hypotheses. The analysis yielded a significant main effect of stimulus type, $F(1,83) = 4.32$ and a grade X training interaction, $F(1,83) = 4.06$; both $p < .05$. Children made fewer errors with the pictorial than with the geometric stimuli ($mean_P = 9.0$; $mean_G = 12.8$). The younger children who received response training made fewer errors (mean = 7.5) than their untrained counterparts (mean = 11.0). The opposite pattern was obtained with the older children (Response Trained mean = 14.2; Untrained mean = 8.4). In addition, the grade X stimulus type X trials interaction was significant, $F(7,581) = 5.04$; $p < .01$ (fig. 1). The fifth-graders made more errors at the beginning of the task. However, after 30 trials, the groups were almost the same. Finally, the Trials effect was signifcant, $F(7,581) = 67.16$, as was the stimulus type X training X trials interaction, $F(7,581) = 2.17$, $p < .05$. Inspection of the data for the interaction failed to reveal any consistent patterns.

Insert Figure 1 about here

The pattern of results indicates that the use of pictorial integrated stimuli did not facilitate later learning. However, the data did indicate that, at least for fifth-grade children, continued presentation of the geometric stimuli (which have relatively little connotative meaning) might interfere with later learning. More importantly, the use of the attentional training strategy did work, altering the performance of children at both ages. This effect will be considered in more detail below.

Discussion

The results support the conclusion that the strategies second- and fifth-children use to attend selectively to a limited set of cues can be influenced. This was accomplished in the present study during the overtraining trials where the children in the response training condition made "passive" responses. These children simply pointed to the stimulus specified by the experimenter instead of making stimulus choices on their own. The effect of that training was to modify the younger children's range of attention to include the newly relevant and redundant cue. The result was that these children learned the shift task with fewer errors. A different pattern was observed for the older children: the training appeared to interfere with how they attended. The fifth-grade children's attention appeared to remain "fixed" on the initial relevant cue during the overtraining trials. Accordingly, these children learned little about the newly redundant cue and made more errors on the shift task.

The finding that this response training facilitated the younger children's learning contrasts with two often cited (but apparently contradictory) assumptions concerning children's attentional ability: (1) the younger child's attentional range is narrower than is that of the older child (Hale & Taweel, 1974a) and (2) the younger child's attentional range is broader than that of the older child (Crane & Ross, 1967). In the first case, the younger child is assumed to be unable to attend selectively to cue redundancy and in the second case the younger child is assumed to be unable to ignore irrelevant information. While each assumption suggests different types of attentional deficits, they lead to at

least one identical conclusion; namely that the younger child fails to attend selectively during learning. Accordingly, the training used here either may have expanded or narrowed the younger child's attentional range.

However, deciding which alternative applies in a specific task is difficult because of a lack of consensus as to the precise function of selective attention. For example, two frequently used definitions describe selective attention as follows: (1) maintaining attention to relevant stimulus cues in the presence of conflicting irrelevant cues (Crane & Ross, 1967) and (2) the flexibility by which subject's control or switch attention when stimulus cues are in conflict (Hale, Taweel, Green, & Flaughers, 1978). Each definition has different implications for children's learning. The Crane and Ross definition implies that subjects monitor only one category of stimulus input; namely, relevant information. Accordingly, the child's attentional range should be narrow. Hale suggested that learners monitor two (or more) categories or sets of cues since the status of relevant information during learning may not be constant. In this case, the range of attention would be broader. These two approaches imply different task demands and prerequisite skills -- vigilance skills (Hale et al., 1978) or response selection strategies (Crane & Ross, 1967). However, either approach may correctly account for performance in different types of tasks, leading to the conclusion that strategies of selective attention may be situation specific.

The variation of the Crane and Ross task used in the present study provided more of a focus on children's attentional

flexibility than on the limitations of children's attention to relevant cues. What was learned about the added redundant cues during the overtraining trials affected learning on the shift task with both the geometric and pictorial types of stimuli. Apparently both younger and older children can deploy attention in a flexible manner, switching between different stimulus cues and/or types of stimulus information (such as the pictorial and geometric stimuli). Hale et al. (1978), who observed similar behavior among eight- and nine-year-old children, called this switching "attentional trading." Such trading reflected a "withdrawal of attention from one type of stimulus information along with increased attention to another when changing demands make it useful to shift attention to the latter" (Hale, et al., 1978; p. 505). The switching between the geometric and pictorial cues represents a similar type of attentional trading. However, since attention to the pictorial cues never was in direct competition with the geometric cues, the transfer of information about one set of cues to another may have represented trading between rather than within tasks. This kind of "serial trading" could be the basis for the switching/transfer of attention that occurs in transfer tasks and determines, in part, the ease with which reversal or nonreversal shifts are learned.

This possibility is consistent with other evidence of the young child's attentional flexibility reported by Birch (1978) and by Lane (1979). Both Birch and Lane told children to alternate attention between simultaneously presented visual tracking and auditory same-different matching tasks. Alternating attention from one task to another or to both at the same time was referred

to as "time-sharing," but may simply represent another example of attentional trading. Eight- and thirteen-year-old children's performance was equivalent, but only when their baseline performance on each task was comparable. Birch and Lane each concluded that younger and older children could use the same attentional strategies when task experience was equated.

The results here also indicated that other types of experience (i.e., the response training procedure used on the overtraining trials) can influence how children attend. The younger children benefited from being told which stimulus to choose. That procedure enabled them to switch from attending to the original relevant cue to newly relevant and redundant cue. The procedures optimized the conditions for these children to learn about the relevant cues. That procedure had a different effect on the eleven-year-olds, who may have been using an attentional strategy which conflicted with the training procedure. That conflict interfered with their performance. Identifying other conditions or procedures in which children's attentional strategies can be optimized, or interfered with, might lead to a more complete understanding of how and when specific attentional strategies are used. This goal is consistent with the following statement made by Stevenson's (1983) regarding the relationship between what children can do and how we conceptualize what they do:

> "When the model of the child is one which defines behavioral development as proceeding from simple to complex, the temptation is to describe younger children in terms of their

> deficiencies. We tend to emphasize what is lacking rather than what is present. A different view of development assumes that it is not the degree of complexity that differentiates children of different ages but the conditions necessary to produce particular kinds of behavior (1983; p 53)."

This conceptual approach may be served by a new outlook and by the use of new and innovative research paradigms, but only if they serve to illuminate the child's potential rather than the child's failures. Too often the task is the variable of interest and not the child's prevailing skills. Our goal has been to use the task to focus on the skills.

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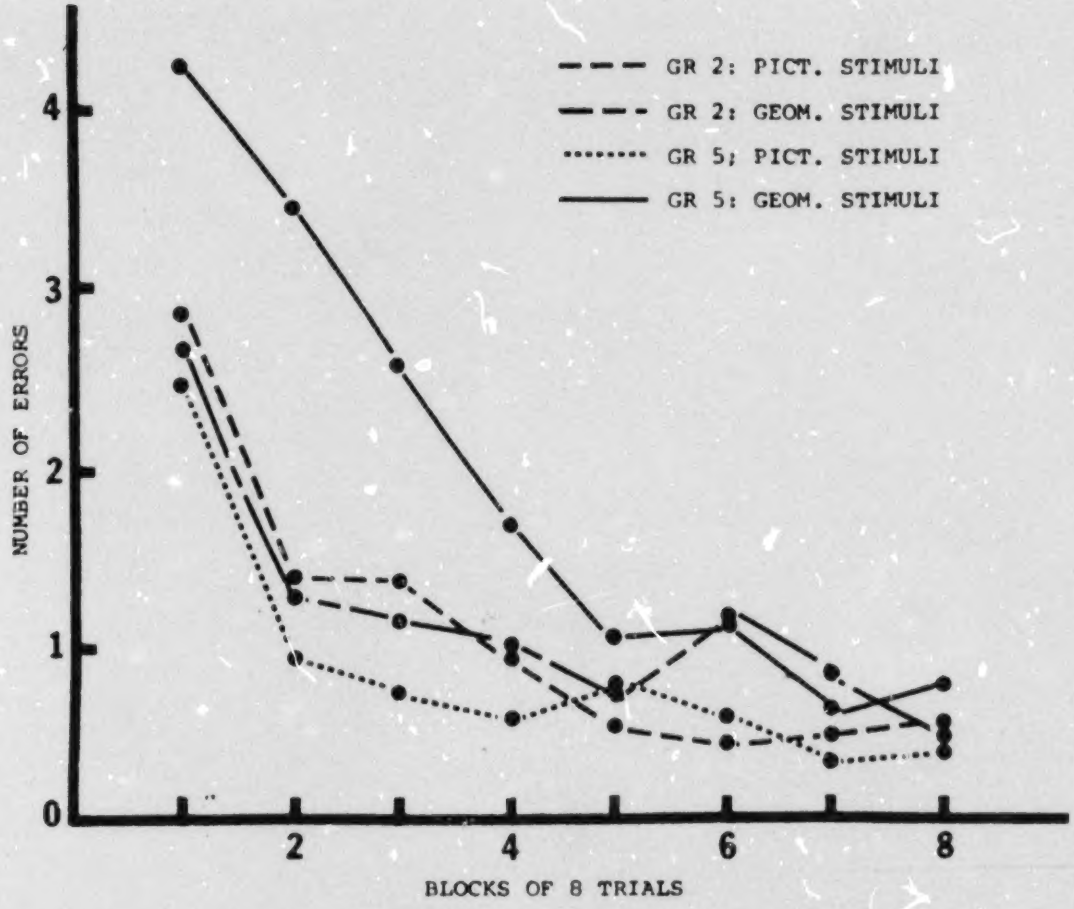
Footnotes

[1]While it is true that this definition of integration would include most if not all, types of discrimination learning stimuli (e.g., compounds of color and shape), the term has been more typically applied to arbitrarily combined elements such as a lamb flying a kite (Hale & Piper, 1974) or a living room couch and lamp (used here). These types of "integrated stimuli" have been used in studies of selective attention, memory, and imagery.

[2]A more detailed description of the Pictorial Integrated stimuli is available from Author Blumberg.

Figure Caption

Figure 1.--Number of Shift Task errors for the Grade X Stimulus Type X Trials Interaction.


GR 2: PICT. STIMULI
GR 2: GEOM. STIMULI
GR 5; PICT. STIMULI
GR 5: GEOM. STIMULI
NUMBER OF ERRORS
0
1
2
3
4
2
4
6
8
BLOCKS OF 8 TRIALS